SCIENCE

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THE MARINE BIOLOGICAL LABORATORY.

BY DALLAS L. SHARP, BRIDGETON, N. J.

THE sixth summer session of the Marine Biological Laboratory, at Wood's Holl, Mass., ended with August '93, and a short review of the station, of its work and growth, will be of interest to *Science* readers, throughout the country, who are at all interested in our advancement in biological thought and investigation.

The phenomenal growth and spendid proportions of the Marine Biological Laboratory, as it now stands, justly deserve the interest and admiration of every educated American.

Starting six years ago, in 1888, the Laboratory was but a single building of two large rooms, poorly equipped for work, with only one boat for collecting material, and a total of seventeen students. The session of '93 opened with three connected buildings more than twice as large as the original, containing thirty-four private rooms, a lecture room, a library, a supply department, five general laboratories, and a total of one hundred and twelve students. Instead of a single row-boat, there are now several at the Laboratory's wharf and beside these a splendid Burgess-built steam launch perfectly equipped for collecting and always at the students' command.

The secret of this extraordinary growth is mainly due to the Laboratory's ideal foundation, its location, its officers and the high grade of its work.

In 1881, at Annisquam, a quaint little fishing village on Cape Ann, the Woman's Educational Society of Boston started a small laboratory for the study of marine zoology For six years investigation was carried on here, with constantly increasing demands for *better* and *more* accomodations, until the necessity of a permanent and better equipped laboratory brought together a number of Boston scientists, who were organized into a corporation under the name of the Marine Biological Laboratory.

Thus it came into existence, and though started in Boston it is by no means a local institution. It can hardly be called national, for students from Maine to California work side by side with those from England, Germany and Japan. Its board of trustees includes a large proportion of America's most prominent scientists, and their aim is to make the Laboratory an institution second to none of its kind in the world.

The location of the Laboratory at Wood's Holl is most happy. It was not the result of luck or chance. Over twenty years ago the late Professor Spencer F. Baird, of the Smithsonian Institution, recognized the advantages of Wood's Holl for the study of marine life, and for many years he and his assistants came here and worked through the summer months. As a result of his work, the United States has established here her most important fishing station, whose buildings are the finest of their kind in the world. Nowhere along the Atlantic coast do the American waters offer more varied or richer fields for the naturalist.

Looking off to the southward from a Laboratory window, Martha's Vineyard is seen stretching away in the distance till its point is lost behind Nonameset, which in turn is followed by Naushon, by Nashuena, by Cuttyhunk and others. Behind to the west lies Buzzard's Bay with its distant shore and the little Weepecket Islands like dots upon its surface. In front again is Vineyard Sound, the Harbor, Wood's Hole, Quick's Hole, and other holes innumerable, all teeming with life and all within easy reach of the student.

What a happy hunting ground! What variety of forms! What wealth of numbers! What a paradise for the naturalist! The sandy shores, the rocky points, the muddy bays, the tide-pools, holes and bottoms from the depths in Vineyard Sound to the shallows of Buzzard's Bay, are all astir with life which the student may study at first hand.

After a year's study at the Laboratory the average student wakes up to the fact that he never knew before what the study of zoology or botany meant.

He is no longer looking at "stuffed things" wired fast to sticks, or withered, shrunken, faded stuff in glass bottles.

The specimens are not stuffed with tow nor wired to the rocks, which he gathers from the shores at Wood's Holl, nor do thy float around in alcohol. He learns many new names, but does not spend the summer committing to memory the check-list of species on the coast. He returns to his teaching or college with a larger idea of life; to his reading and work asking how and why and when. He returns to every thing with renewed vigor and enthusiasm, except to the college museum.

The work done at the Laboratory is divided into two very distinct divisions. The institution is at once a centre for the advancement and for the diffusion of knowledge; it is a school for teaching and a station for research: and acordingly the students who annually attend are divided by a distinct line into pupils and investigators. In the first category come those who have had but an elementary course in zoology, who are practically unacquainted with the methods of work, who must needs have a broad and general knowledge of the structure of the various groups of animals, must become acquainted with the great principles of biology, and the use of the naturalist's instruments, before they can engage in original research.

For the needs of this class of students the Marine Biological Laboratory is eminently fitted. In no other institution of its kind has this department been so carefully and thoroughly developed. The Marine Biological Laboratory is unique in this. It stands alone. It is an entirely new departure, and the student who intends to teach or work in any line of biological investigation has an advantage here that is entirely without equal.

Each student has his regular table, his locker for instruments, his own reagents and complete outfit for work. In the centre of the room are the aquaria where his living material is kept. Here he may work, as long as he likes, with abundant material, free to ask questions, and with some eniment biologist always at hand in case of difficulty.

The instruction is largely personal. From 9 till 10 A. M. there is a general lecture, bearing on the form that is to be studied that day. This lecture is always given by some specialist in that particular group. To-day, for instance, the form under study will be a sponge; the morning lecture then will be by some investigator who is making sponges his special study. After this lecture the day is given up to study, and the instructors are always near, with criticism and suggestion, clearing away the difficulties as they arise, until the student, working form after form, gradually masters the technique and learns in part to interpret facts for himself.

After this course, if he chooses to return another year and persue the work further, he takes a table in the upper laboratory, where he is given some problem to solve, which is not too difficult, and here again he is helped over the hard places, until, having had sufficient preliminary training, he is capable of choosing and solving his own problems.

For those who carry on special investigations private rooms are provided, where they may work undisturbed and in perfect quiet.

This year there are thirty-four of these rooms, each occupied by some investigator, working at some problem whose solution will have an important bearing on the scientific thought of the day.

This summer gathering of our biologists and scientists at the Marine Biological Laboratory, apart from the natural advantages of the place, is of the greatest help and importance. There is an enthusiasm and stimulus in the numbers and personal contact which nothing else gives. Men of different schools, working in widely separated fields, here meet and compare ideas and methods. Their lines of work continually cross and the help of a specialist's suggestions at these points cannot be overestimated. Hardly a paper goes to press, but that it has first received the honest judgment and criticism of those whom the author most wishes to reach.

Every point of interest and doubt is carefully weighed and discussed, and very seldom does error escape detection. As often happened this year, papers which have been long in preparation, and discoveries that are entirely new, are delivered as lectures before the whole student body, and are afterward discussed, allowing every one the privilege of expressing his criticism and opinion. This is not only of immense value to the author, but all present are thus kept in the very van of scientific thought.

The student who wishes to come to Wood's Holl does not necessarily need to be working some problem of marine life, to enjoy the advantages of the Laboratory. His work may be such that requires the fresh-water ponds, or the woods and fields, it may be; if so, they are all at hand. The character of the surrounding land is almost as varied as that of the water. The green and rolling hills, the winding road-ways, the quiet, shady ponds,—all combine to make the country round about Wood's Holl a land of delight to the summer visitor, whether he be student or pleasure seeker.

One of the newest features of the Marine Biological Laboratory is the Department of Physiology. This was first opened last year under Dr. Jacques Loeb, of the University of Chicago. This year professors from Harvard Medical School, the College of Physicians and Surgeons, from Johns Hopkins and other such schools have occupied the rooms and have placed the department on a sure and successful footing.

The Botanical Department gave a course in Cryptogamic Botany in reference to marine algæ and a parallel course in comparative forms of Fungi. The department was crowded, several specialists investigating problems connected with marine plant-life.

The "Supply Department" of the Laboratory, while it is a side issue and of no special concern to the summer student, is nevertheless an institution of great interest and importance to every zoological teacher in the country. The collecting is under the care of Mr. F. W. Wamsley, who has had much experience in the work, and he has reduced the business of collecting, killing and preserving, to a science.

Full data accompany every specimen. The date, even the hour in some cases, the location, depth of water, character of bottom, and many other minor details, are carefully noted. Then the killing fluid is tested and proportioned, and so on through every step in the process of fixing the tissues, which is often very complicated, until the specimen is finally preserved in the proper alcohol. As the value of a zoological specimen preserved for class use, or for histological purposes, depends entirely upon the methods used in its preservation, it should be, and is, a source of great satisfaction to know that the Marine Biological Laboratory has established a department where such material can be supplied, which formerly could not well be had short of Naples.

The excellent library of the Laboratory is at all times open to the student. The Laboratory is a regular subscriber to about thirty of the leading biological and other scientific papers of our own and foreign countries. Besides this, the Boston Society of Natural History has generously placed the use of their library at the disposal of the Laboratory, and the library at the Laboratory has been in this way effectively supplemented.

The evening lecture course for the session of '93 was like that of former years, dealing mainly with subjects of general interest. Night after night the little lecture room was crowded with the students and their friends and the people from the village.

Such, in brief outline, is the Marine Biological Laboratory at the close of its sixth year.

We are justly proud of what it has been and now is. Its short history is one of severest struggle. What it now is, is owing to the generosity and earnest labor of a few; what it is to be, depends, in part, on your generosity and mine. What it *may* be, is summed up in these few words from the last report of its director, Dr. C. O. Whitman, "We have now seen about the limit of what can be accomplished without funds. The two functions of instruction and investigation have worked admirably together, each growing stronger in the success of the other. We have endeavored to keep the two properly balanced, but I think we have nearly reached the limit of our capacity for instruction with our present space and means. We already see that to tax our teaching forces much more, would not tend to improve the side of investigation. For further development, then, two things have to be provided, namely, *room and funds*. As we cannot well enlarge our building, and as the conditions for both branches of our work could be immensely improved by providing a separate building for the investigators, our next step is clearly defined: It is a suitable observatory for the exclusive use of those engaged in original research. Preparatory to this, a site is to be selected and secured. This done, the plan of the building worked out, the equipment estimated, the income necessary to the maintenance of the observatory, with its officers and scientific staff ascertained, we shall be prepared to lay the whole matter before any one who may be disposed to contribute to the foundation of a biological observatory—an observatory which shall be an honor to America, and worthy of that promising science of the future to which the world looks for grander discoveries than have yet enriched human knowledge or contributed to the welfare and advancement of the race."

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HOW CHEMISTRY IS BEST TAUGHT.*

BY CHARLES F. MABERY, CASE SCHOOL OF SCIENCE, CLEVELAND, OHIO.

THE subject "How chemistry is best taught," which has been proposed to us for discussion, has a serious interest for all persons who are engaged in teaching chemistry, and it is of especial importance to those of us who have in charge the preparation of young men for professional employment. In view of the prominence of scientific subjects and methods in the present systems of education, it is incumbent upon the adherents of these methods to demonstrate by their results that they are not in error in assuming that science should have an equivalent place with other departments of knowledge. In the higher institutions this question has received a definite answer; in the secondary schools evidently much has yet to be accomplished in the direction of general education as well as in the preparation for higher study.

That the importance of a knowledge of elementary chemistry is apparent to all who are capable of appreciating its usefulness, is evident in the recent extension of instruction in the secondary schools. In the larger portion of our high schools, however, physical science still occupies a subordinate place, or it is taught merely from text-books with little, if any, laboratory training. Probably the chief hindrance to any radical change is a lack of appreciation on the part of the public. If parents could be brought to see that their sons and daughters would receive a better education if physical science properly taught formed an essential feature of the high school course, the change would not be long delayed. That the training of many teachers is scarcely more comprehensive than they are called upon to impart is of less importance, since at present those who are educated in the higher institutions have better opportunities, and those who are deficient can improve their knowledge in special courses for teachers. Doubtless the many popular movements of the present day will exert a beneficial influence in extending an acquaintance with the application of scientific principles. Such unique and instructive object lessons as that which has been designed, under the direction of Prof. Ellen H. Richards, for the Rumford kitchen, in the Columbian Exposition, cannot fail to attract public attention. It requires no particular training in observation to recognize the difference in nutrition of foods which have a widely different nutritive value; but when an appetite whetted to the sharpest edge in an endeavor to see all the exhibits in the Liberal Arts building in one visit, and the unavailing efforts to extract a crumb of comfort from the places so improperly named, is brought in contact with the wholesome dishes prepared in the Rumford kitchen, and their satisfying influence, the numbers representing the food values will be in a favorable connection to awaken a desire for further information. The same principle is applied in a different manner in the exhibits from the agricultural stations which explain the composition of dairy products, of animal foods and the methods of chemical investigations. These exhibits have a particular interest for persons engaged in agricultural pursuits since they are a part of the well-directed efforts of the stations in disseminating knowledge. Probably in no department of education has there been a more substantial growth during the last twenty years than on the part of intelligent farmers in applying the practical information coming to them from the results of investigations carried on at the experiment stations. These illustrations may seem somewhat removed from the main question before us, but I am convinced that the efficiency of higher instruction in chemistry will be greatly improved when students coming to us from the secondary schools shall have had the advantage of practical training in elementary physical science, and I believe this will be the sooner accomplished through a recognition of its benefits in the affairs of every-day life.

I think we shall all agree that the best argument to be urged in favor of a prominent place for chemistry in any grade of instruction is the value of experimental methods for the development of mental power. This feature should naturally appear with especial prominence in courses leading to the degree of Bachelor of Arts; and if the schools of science are to be maintained on a higher plane than the trade schools or shops, the courses of study must be conducted with reference to the attainment of mental discipline and scholarship. In the courses in chemistry I am unable to see why this should interfere with the acquisition of practical knowledge.

The guiding star to successful teaching in chemistry is the personality and enthusiasm of the instructor. With the great increase in attendance in many institutions the earlier relations between student and instructor, which were frequently mingled with deep personal feeling, somewhat akin to veneration on the part of the student, are well-nigh impossible. Nevertheless, an enthusiastic teacher with tact and good judgment has little difficulty in maintaining a profound interest even in large classes. In successful teaching we all know how much depends upon the attitude of the instructor toward his students. Courteous relations, with a clear understanding that teacher and students are mutually interested in the acquisition of knowledge, readily secure the confidence and esteem of a body of students, and the instruction need seldom be interrupted by questions of conduct. A faithful teacher does not limit his attention to the brighter minds; students slow in comprehension but earnest in application secure a store of information which will be used later to the best advantage. It was a wise teacher who said: "I am faithful in my duty to dull students; in my old age I may need favors of the men of wealth."

In assimilating their methods from European laboratories, the chemists of the United States, untrammelled by traditions and unrestrained by the influence of any particular school, have been in favorable conditions to appreciate the labors of the great masters of other countries. Unfortunately, it may be, in the wonderful development of our natural resources, the temptation to enjoy material benefits may have retarded the growth of orig-

*A paper read before the section of Didactic Chemistry in the World's Congress Auxiliary of the World's Columbian Exposition at Chicago, August 26, 1893.

inal investigation; yet looking toward the future the erection of so many large laboratories cannot fail, under judicious control, to contribute to the advancement of knowledge. A marked individuality in our methods is apparent even in a casual inspection of American laboratories. Variation in details is a natural consequence of differences in the temperament of different peoples; and teachers educated abroad have perceived the necessity of adapting the methods in which they were trained to the peculiar conditions.

With some hesitation I approach that aspect of our subject which relates to the details of methods, since the best success in teaching is so dependent on the personality of the instructor that it would seem presumptuous to suggest a rigid scheme for all. There are certain principles at the foundation of successful teaching, however, which may properly be presented for consideration, especially since this paper is intended as an introduction to general discussion. I have already alluded to an unsatisfactory condition in the methods employed in the secondary schools. In some of the high schools, as we all know, there are teachers who are thoroughly imbued with the spirit of scientific study, yet competent teachers are often limited in their efforts by a heavy burden of other work, or by a need of the necessary appliances. There can be no question that the high school courses would be benefitted if every pupil received systematic training in elementary physical science, and I believe it is consistent with due attention to other subjects, and that it can be accomplished without any unreasonable pecuniary burden. As an expeditious and effective method for teaching chemistry in the high school, I would have the teacher meet the class before the lecture table and demonstrate, experiment and explain, simply as a convenient mode of teaching classes as one pupil should be taught. The experiments should be repeated by the student in the laboratory, under the immediate oversight of the teacher, with the note book close at hand. A text-book is necessary, to give information which the teacher has not time to include; but no text-book can supply the need of personal teaching. Occasionally teachers with limited knowledge are led to adopt methods of questionable utility by the arrangement of certain text-books. Some years since a teacher in one of the high schools in the East, in which little attention was given to laboratory work for students, remarked that his pupils must have a thorough knowledge of valence and structure symbols. The topical arrangement of the subject may be left to the discretion of the teacher, and the quantity to the length of time available; but it should never be forgotten that the educational value of such instruction depends upon the development of skill in manipulation, of correct habits of observation and in recording notes, and of the true spirit of scientific thought. Whatever of practical information may be included will enhance the utility of the instruction.

In the higher institutions the first course is general and descriptive chemistry, of which every person who expects to engage in any scientific pursuit should have a thorough knowledge; and, as has been suggested, this subject should have a suitable place in college courses. Concerning details of the most efficient methods in teaching general chemistry, no doubt an extended course of experimental lectures, closely connected with laboratory practice, affords the best training. The ground can be fairly covered in seventy or eighty lectures, with four to six hours a week of laboratory work, so arranged that the lectures of each week shall include the experiments for the laboratory. Weekly recitations on the subjects of the lectures and laboratory work enable the instructor to control the progress of his students. When students first enter the laboratory it is essential that they are impressed with the necessity of accuracy in the details of experimental work. This important lesson may easily be taught by means of experiments capable of affording quantitative results; by some instructors such experiments are occasionally introduced throughout the course, with the same object in view. There should be sufficient instruction in the laboratory for careful oversight of the experimental work and the note book of each student. Moreover, I am convinced that it is unwise, in any grade of undergraduate study in chemistry, to allow students in laboratories without constant supervision; when left to themselves they are apt to loiter, to contract careless habits and to waste material. Then a laboratory is held responsible for accidents, even though they occur through inexcusable carelessness of students. Every instructor in charge of a laboratory will, no doubt, recall heedless moments on the part of students. Some years ago, just as I entered my qualitative laboratory one day when the assistant was out of the room, I observed a student inflate his lungs twice from a bottle containing a freshly charged solution of hydric sulphide; he immediately fell into the arms of a companion, and it was some time before he recovered. Probably another inflation would have proved fatal.

This fellow was a sophomore, having taken one year in general and descriptive chemistry; he was fairly bright and had been using this reagent during several months. But some question arose as to the odor of the unadulterated gas, and, forgetting the precepts of his freshman year, he attempted by a direct experiment to ascertain the truth. What has been said concerning the personality of the instructor applies, perhaps, in a more restricted sense to the student. While methodical habits are to be strenuously insisted upon, the methods may be sufficiently flexible to allow the student to reach his conclusions in his own peculiar way; the particular form of the lecture and laboratory notes, for example, can be left to the preference of the student, provided they are well written and complete.

For other students than those who desire special training in chemistry or in allied subjects, an extended course in general and descriptive chemistry provides ample knowledge of this subject. Analytical chemistry is next in the sequence of studies, and for evident reasons qualitative analysis is first undertaken. On account of its great disciplinary value I regard this subject as one of the most important in the whole course of chemical training. It enables the instructor constantly to test the faithfulness and proficiency of the student, and beside the mental discipline, the student acquires a comprehensive knowledge of methods of separation and identification, which is the foundation of quantitative analysis. Elementary theoretical chemistry, or chemical philosophy, may be conveniently and profitably taught at the same time with qualitative analysis, especially since a familiarity with stochiometry and chemical reactions is essential in a good understanding of quantitative methods.

Thus far, in teaching chemistry, probably the methods are not materially different in the college and the technical school. Indeed, in the more advanced subjects, the principal difference is in the attention which should be given to the acquisition of practical knowledge in the technical courses. The methods of quantitative analysis are well adapted for the development of skill and dexterity in accurate manipulation, and to the chemist they are indispensable. As a preparation for professional employment the training in methods should be sufficiently comprehensive and thorough to enable the student to appreciate the conditions of any analytical problem; and, further, I deem it of much importance that students have practice, under guidance, in all typical standard methods.

It is not sufficient that men are carefully trained in methods which impart skill and accuracy; it seems more desirable, for example, that men who enter the iron and steel industry are thoroughly familiar with the standard methods of iron analysis than to rely upon skill and general knowledge to acquire the special features in actual practice. The first lessons to be learned in the quantitative laboratory are accuracy and confidence; the importance of a close economy of time and effort must be appreciated, and an intelligent student will soon perceive the numerous ways for conducting analytical operations rapidly without haste. When a chemist assumes the duties of a position every motion has a pecuniary value, and results are demanded in the smallest limit of time. This requirement is sometimes urged in favor of undergraduate training in rapid methods. While some practice in this direction would, without doubt, be serviceable; in three terms, at most, which can be devoted to quantitative analysis, the time is fully occupied in gaining a familiarity with methods, and in passing from one analysis to another the conditions are not favorable for commercial rapidity. As in actual practice it is only possible to attain to the highest degree of accuracy and celerity when the attention of the analyst is limited to a moderate number of determinations which are continually repeated. Experience shows that well-trained students are not long in acquiring commercial dexterity, even to reporting the percentage of carbon within five minutes after a ladle of steel is poured into the mould, or a complete analysis of blast furnace slag within thirty minutes. If attempts were made to give such practice to students, there would still be much to learn in the different conditions in the laboratory of the manufacturing plant.

A branch of our subject, which has doubtless occasioned some of us much perplexity in our endeavors to give it a suitable place in an undergraduate course, is organic chemistry. Our difficulty is partly due to the feeling on the part of certain students when they have gained a good acquaintance with quantitative analysis, with the consciousness that they can secure some pecuniary return from their attainments, that they have learned all of chemistry that can be of service to them. Usually such students may be made sensible of their error, although, unfortunately, the importance of a broader view is not always appreciated until a knowledge of this subject is needed in professional occupation. That organic chemistry is a difficult subject students are not long in perceiving. It is not sufficient in a course of lectures that the principles and methods are understood, they must be learned. The importance of a broad and thorough training in theoretical and descriptive organic chemistry as a part of a chemical education is beyond question. As a part of the preparation for technological and applied chemistry, organic chemistry can most conveniently be placed in the third year; yet without some introduction I have found this subject too difficult for third-year students. The plan which I have adopted with satisfactory results includes recitations in the first term of the third year from an elementary text-book, with the following lectures extending throughout the second term and the first term of the fourth year. So far as possible laboratory work should accompany the lectures, although from the pressure of other work the greater portion of the experimental work may be pushed forward into the fourth year. In connection with the lectures, students should be required to extend their knowledge by reading, and recitations are necessary to ensure faithful application. With this arrangement the principal laboratory work of the fourth year includes organic chemistry and chemical technology, assaying, gas analysis; and such other special subjects as may seem expedient can be provided for here. A course of lectures in metallurgy are of advantage to students in chemistry, and they may be attended during this year; some additional instruction in theoretical chemistry can be given with profit.

For the utilization of chemical skill the field of manufacturing or applied chemistry is full of promise, although in this country it has largely to be developed. Suitable preparation for industrial occupation demands thorough training in the directions already suggested, and beside, a good knowledge of technical processes with the aid of laboratory work, so far as it is feasible to experiment with these processes on a laboratory scale. Concerning the best methods for teaching this subject, no doubt courses of lectures, supplemented by reading, are to be preferred, especially if part of the lectures can be given by persons engaged in professional pursuits. Several recent compilations, in a convenient form for the use of students, are a valuable aid.

The range in laboratory work is of necessity somewhat limited; it must consist principally in the preparation of chemical products from crude materials, in the study of mordants and dyes and in testing the efficiency of certain features of industrial processes on a laboratory scale. The preparation of theses or written accounts of various processes should also form a prominent feature of a course in technological chemistry. Institutions fortunately situated near manufacturing establishments, afford valuable opportunities to students, who are enabled to study industrial methods in actual operation. Such instruction, supplemented by laboratory practice, constitutes the best possible education in applied chemistry that an institution can provide.

Any discussion of the details of a chemical education must be incomplete without some reference to related subjects, either such as are closely allied to chemistry, or those which are essential in the proper mental development of every well-educated person. Evidently this portion of our subject may be considered from more than one point of view. In a course of four years in the school of science, there should be thorough training in mathematics, so far as calculus, and it can be no disadvantage to make a certain portion of this subject required or optional. Every chemist who aspires to a position beyond that of an analyst will be called upon to plan and oversee the construction of appliances and buildings; in fact, ingenuity and mechanical skill may occasionally be as serviceable as chemical knowledge. There are, therefore, good reasons for the acquirement, by every student, of a good understanding of mechanical drawing and of elementary mechanics, and this may have led to the foundation, in several institutions, of a course in chemical engineering. No doubt this course is in demand by persons who desire proficiency in the engineering features, but students who expect to engage in applied chemistry can hardly afford to omit any portion of the undergraduate training in chemistry. Nothing need be said as to the importance to all chemists of a thorough discipline in descriptive physics with laboratory practice. A familiarity with the principles of heat and electricity and with the manipulation of electrical currents are among the more important requisites. The rapid growth of electro-metallurgy indicates large possibilities for the application of electrical energy in this form, and it can evidently best be undertaken by the chemist who possesses a good knowledge of electricity. The literary training in scientific courses is usually limited to the English branches and the modern languages; without a certain acquaintance with the latter the chemist would be seriously restricted in the sources of his information; and, moreover, to scientific students, it would seem that the French and German languages should be taught as

much, at least, for mental discipline and culture as for their practical usefulness. Of the importance of thorough discipline in the English language and literature, history, logic and political economy it is not necessary to speak. Determinative mineralogy may be provided for in the second or third year. Courses in agricultural or pharmaceutical chemistry, or in other special fields, should differ in the details of the third and fourth years from the course outlined above.

In college and university courses, theoretical chemistry and chemical literature receive more attention, and in general less attention is given to practical applications. I do not accept the idea sometimes expressed, that original investigation should not be attempted outside of the university. We are all too well aware of the difficulties in the way of carrying on special study in connection with the responsibility of undergraduate courses; and yet I am sure we appreciate the influence of such work in the atmosphere of the laboratory, as well as upon the instructor himself. Then there are always in the laboratory bright students who are able to undertake with profit the study of special problems. As a part of the preparation for teaching I look upon a certain acquaintance with the methods of original research as an essential attainment; I do not intend to assert that without it there can be no good teachers, but it certainly strengthens the equipment of a teacher who aspires to a high position.

Earlier in this paper I endeavored to give an outline of what seem to be the principal objects to be kept in view in teaching chemistry as an educational subject. Students continue in chemistry with the intention of securing professional employment either in teaching or in applied chemistry. How often are we met with the question as to what is the prospect of employment after graduation; whether the inducements are more promising in teaching or in practical fields. Concerning teaching as a profession, the reply is easy: a person with an aptitude for teaching and with broad training has little difficulty in securing a position commensurate with his attainments, especially at present, with the wonderful extension of our educational institutions. But the number of positions is limited and there are few vacancies; if they were abundant not all persons, even with the best possible preparation, would succeed in teaching chemistry. In applied chemistry the conditions are not the same. With our enormous stores of natural products yet undeveloped, vigorous enterprise in business operations and great industrial wealth, there cannot fail to be rapid developments in the fields of manufacturing chemistry. Within the ten years just elapsed we have witnessed great changes; manufacturers who, ten years ago, conducted their operations almost without the aid of chemical skill, now employ several chemists. Eight years ago I visited a large plant for the manufacture of sulphuric acid, which contained neither a Glover nor a Gay Lussac tower. Further improvements, which are necessary for the production at home of the chemical products that are now imported in large quantities, require broad qualifications with extended experience; if our graduates are not sufficiently well trained chemists will be secured elsewhere.

If there are portions of the educational field in chemistry which appeal to us with greater force than others, perhaps the elementary teaching in the secondary schools and the advanced study in preparation for teaching or for positions requiring independent skill and originality in methods are worthy of attention. The recent growth of knowledge within special fields has introduced new features into methods of instruction. In addition to courses which are adapted for all students, those who intend to undertake investigations in any particular direction should have training under the guidance of a specialist in that field. There are many economic problems of the utmost importance awaiting solution, which require not only the application of all accumulated knowledge, but the discovery of new methods. The maintenance of a healthful water supply and the economic disposal of sewage are serious problems for the present generation, and the engineer must be aided by the best skill of the chemist and of the bacteriologist.

Every laborer is directly interested in the promotion of investigations on an economic and healthful food supply. To the great army of workmen who are struggling to support families on incomes of three or four hundred dollars a year it is a matter of serious importance to secure the best nutrition at the smallest cost. Yet it is rarely, if ever, that a judicious selection of food materials receives attention; it is usually a question of individual taste, so far as the means at hand will permit, with a complete ignorance of any principles of economy or health. In these directions and others of no less importance there are great opportunities in the domain of sanitary chemistry to render inestimable benefits to humanity.

What has been said of sanitary chemistry applies with equal force to medical chemistry, to agricultural chemistry and to other special fields. But I feel sure that the details of methods of instruction, as well as a consideration of methods based on other recent discoveries, such as the use of models in teaching structural chemistry, can best form a part of the general discussion by teachers who are especially occupied in those particular fields. Perhaps, also, the great border land between chemistry and physics, or chemical physics, should receive attention from those whose investigations are extending our conceptions of the fundamental principles of chemistry.

If I have presented this subject more especially from the standpoint of the preparation for professional occupation, it is because this seems to be the principal demand for instruction in chemistry beyond the elementary branches. But if the value of training in chemistry as a factor in liberal education has not been set forth with due prominence, it should receive just consideration in the discussion which follows. I have not attempted in this paper to include methods or conditions outside of our own institutions; yet we cannot fail to derive great benefit in extending our knowledge of the methods in other institutions through the eminent professors with whom it is our good fortune to meet.

NOTES ON THE WOOD OR FALLOW ANT OF SOUTHEASTERN MASSACHUSETTS.

BY J. B. WOODWORTH, CAMBRIDGE, MASS.

ANECDOTES of the ant form, apparently, a large part of the minor contributions to journals of natural history. The fact that so many stories have been published, and the hope that the following will interest some student of the psychological habits of ants, encourage me to relate two observations of my own upon the behavior of the large Wood or Fallow ant (*Formica rufa*, Linné) of southeastern Massachusetts.*

While examining the sands of Horse Neck Beach, opposite Westport Point, Mass., on July 25th, 1893, I had my attention called to a large winged ant, with a reddish brown head and prothorax and black abdomen, which started to run away from a shell on which I had trodden. I stepped back a pace, when the ant, perceiving me, began to approach. Upon this movement I continued to retreat in order to get out of her way, but finding that the creature still pursued me, I was led to see how far

*I am indebted to Mr. Samuel Henshaw, of the Museum of Comparative Zoology, for reference to McCook's account of this ant in the Trans. Amer. Ent. Soc., Vol. VI., p. 253, and for naming the form here referred to.

the ant would continue the pursuit. Between the water's edge and the dry sand of the upper beach was a strip of wet sand some fifty feet wide and gently sloping. Over this area the ant followed me with strange persistence, both with and against the strong southwest wind then blowing. Not only would she follow me up on successively drier and firmer sand to the edge of dry sand, but back again to the water's edge, so that once she was overtaken by the swash of a small surf. The ant followed readily at a distance of three feet without regard to the direction of the wind, but, at a distance of six or more feet, entirely lost the trail. This circumstance, with the additional one that when I walked in a circle she would leave my footsteps and take a direct path towards me, shows that she was guided by sight rather than by the sense of smell.

When allowed to come up to me, the ant crawled under the shadow of my shoe and rested on the sand, and once crawled over the uppers, but returned to the space forward of the heel. When led to the dry sand she would cease to follow, and would begin to care for her chitin. In the course of the few minutes I gave to watching her, the ant followed me upwards of two hundred feet on the wet sand of the beach.

The difference in the behavior of this ant on the wet and dry sand seems to afford a clue to its mental processes. It seems to me probable that the ant had a sense of peril in its position on the wet sand, which was liable to be overrun by the sea, and that she turned toward me as she would have to a tree, or other high object, as a means of escape.

A more striking instance of intelligence in the same species of ants fell under my observation upon the island of Martha's Vineyard. These ants here, as elsewhere, build hills from one to three or more feet in height. The singular activity of the creatures, when disturbed, often led me to offer slight provocations to the occupants of one of these hills. On the occasion which I am about to describe, a number of workers were running back and forth over the summit of a hill, when I spat on it. At once the ants nearest the objectionable meteorite rushed towards it, and with their antennæ made an examination. These workers then ran a little distance away, picked up each a large grain of sand coated with a yellowish clayey film, and carrying it to the edge of the liquid, threw the pellet hastily in. This process, engaged in by at least a dozen ants, soon resulted in filling up the little pool. As these clayey pellets were thrown into the liquid they changed color through the absorption of the water by the clay. The absorption of the spittle by the pellets was evidently not yet complete, when all but one of the ants went about their customary walks. This solitary sentinel placed a pellet on the little heap and watched it soak up water, the pellet changing, as it did so, its yellowish color for a slaty hue. Another pellet was brought up and piled on as the others had been, but the process of absorption was now complete, and this last grain did not change color. The ant stood off at a distance of about half an inch from the grain he had deposited, intently watching the effect of his labors. When after a few seconds it was to be observed that the last grain was not affected by moisture, this ant turned abruptly away and joined his fellows, and no more attention was given to the object which had caused them so much concern.

The obvious effect of this application of clayey pellets was to prevent the moisture from penetrating through the roof of the ant hill into the cavities beneath. This was a clear case of stopping a leak, and that these ants know the value of sandy clay as an absorbent seems further illustrated by the frequency with which these clay-coated grains of sand are distributed about their hills. After rains, the ants may be seen bringing these objects up out of the peripheral holes of a hill and placing them on the dome to dry. It would be interesting to note whether or not dry pellets are taken below to serve as sponges in drying their underground rooms.

PROBLEMS OF ZOOLOGY.*

Ladies and Gentlemen :—Let me assure you that I am not unmindful of the favor shown in electing me to open this International Congress of Zoölogists.

Thirty years have nearly passed since I had the pleasure—as a then resident of this bustling city of Chicago—of listening to a series of lectures on zoölogy by Louis Agassiz, and as I recall the popular interest and enthusiasm which the great master inspired, and the singular activity and devotion of Kennicott, Stimpson and others of Chicago's earlier zoölogists, I am led to hope for a renewal of that early spirit and enthusiasm as a result of your meeting here.

Zoölogy, but a few years back, dealt chiefly with the habits, structure and classification of animals, and was weighted with two prevalent fallacies which theology had so generally impressed on the human mind. These were: the Biblical idea of the creation of organisms as they now exist and their consequent fixity and the homoistic notion that man was, in physical as well as psychical endowment, apart from, and not a part of, the rest of the animal world. Released from the oppressive incubus of these long-cherished fetiches, zoology has, during the past quarter of a century, bounded into the front rank of the sciences, with so many of which she is so intimately bound.

Inspired and guided by the search-light of Evolution, which reveals and makes intelligent so much that was hidden or unmeaning before, zoölogy must lead her sister sciences in all study of the genesis of life upon our planet, whether in past or present time. With the induction of the unity of all psychic phenomena and the conviction that these are inseparable from animal organization, it is her mission to give rational explanation of the subtlest of such phenomena and to check the vagaries which exist as to their abnormal manifestations; for even among lower animals there are senses and sense-organs not yet understood by us, while some species have developed a telepathy which, in its power and ease of demonstration, may well astonish those who have hitherto confined their investigations to man.

Deeper study of electricity, as exemplified in the animal world, may help the electrician to a better understanding of the nature of that force, the practical application of which to the affairs of civilized man has made such gigantic strides of late: while animal phosphorescence may yet illumine, when better understood, the path of the physicist in his investigations of the phenomena of light. Animal mechanics, as exhibited in flight, may hold the solution of practical aeronautics, which promises to cap the marvelous and momentous discoveries of the century; while to the inventor they are pregnant with yet untold and unthought-of suggestions.

That branch of zoölogy which concerns the interrelations and interactions of animals is not only fascinating to the philosophic student, but has a most important economic bearing, especially to those engaged in agricultural and horticultural pursuits.

But the subject which just now seems to be receiving most attention from zoölogists, is heredity, and the cognate question which has divided us into two opposing camps, as to whether or not characters and functions acquired during the lifetime of the individual are trans-

*Remarks made at the opening of the International Zoological Congress, Chicago, August 19, 1893, by Dr. C. V. Riley of Washington, D. C., as Honorary Chairman.

mitted to the offspring. The solid fabric which Darwin did so much to erect, and which is essentially based on the affirmative proposition, has been most persistently stormed, especially by a certain class of embryologists, and the question is too complicated and far-reaching to be lightly considered. It may be well to bear in mind, however, that the solution of the problem involves the psychical as well as the physical facts, and that the former cannot be revealed by scalpel or microscope. The naturalist who studies the development, and the actions of living organisms, in their relations to each other and to their environment, and who seeks to confirm his views by experimentation is, in my judgment, better qualified to draw reliable conclusions than either the histologist or the embryologist. Modern laboratory methods of zoological work, encouraged by the importance of bacteriology, have been so generally influenced by the microscope that they have pushed beyond the short-line of safe induction, and we already hear the murmurings of the reactionary wave which will carry us back toward the more comprehensive methods of the older school of naturalists whose names adorn the annals of our science. The microscope, however important in revealing the processes of growth, will yield us the secret of heredity no sooner than it will yield us the secret of life itself.

The latent potentiality contained in the germ, and the psychological directing force which modifies its later development, must always escape such methods. What we now most need to establish any sound theory of heredity is experimentation, intelligently planned and carried on through a series of years, not alone during embryonic, but during the whole development of the individual, and to include all the elements in the problem. Such experimentation on a sufficiently broad scale can hardly be undertaken by individuals, and the institutions which liberally endow and equip a chair of experimental zoölogy to this end will deserve well of mankind. The zoölogist, while skeptical of the ordinary theological and metaphysical interpretations of mind phenomena, is not disposed to dogmatize. His attitude is one of agnosticism on all questions as to the origin, nature and end of life, whether in its simpler or more complex manifestations; and he simply insists with Wordsworth that, "to the solid ground of Nature trusts the mind which builds for aye!"

The subdivisions of our science in which just now investigation is most active are those which shed light on the general subject of animal evolution, and our program shows that palæontology, embryology, kinetogenesis, bioplastology, heredity and kindred subjects will not lack for eminent exponents. It would be unwise to delay proceeding with such an interesting program by further remarks of my own, and I will at once call for the reading and discussion of the formal papers.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Red Birds and a Grosbeak.

A friend of mine bought a pair of young red-birds, from a lad who had taken them from the nest. At the same time he gave her a rose-breasted grosbeak, which he said he had found sitting on a bush, and "looking sick like." The grosbeak had no wounds, and no broken bones, and my friend placed it on a perch in the cage with the red-birds. It remained there twenty-four hours, refusing food and drink, drawing itself into a heap, and looking very miserable. Meantime the red-birds were vociferously hungry, but unable to take food for themselves, and my friend was obliged to feed them by taking them in her hand, and putting the food into their mouths with a little stick. The grosbeak surveyed this proceeding very intently, with an expression of scorn for human awkwardness!

As, during twenty-four hours, the grosbeak had seemed to make no improvement, my friend, taking him in her hands, gave him a minute examination, and found on the back of the neck the skin raised in a clear, tense bubble, as large as a bean, and of a yellow hue. She clipped a little hole in this bubble, using a pair of small sharp scissors. Only air exuded, no pus nor moisture; in a moment or two the rising was gone, and the skin resumed its place. She rubbed the incision with a drop of oil, restored the bird to the cage, and within ten minutes he was eating, drinking and hopping about in fine style.

He at once installed himself as foster-father to the red-birds. He hung over them with soft "feeding cells," holding the prepared food, and dropping it into their open throats. The little birds throve under his administration, and in a week were taking care of themselves.

A few months later, my friend being away from home over night, the servant who had charge of the birds, neglected to put any hard-boiled egg in the cage, putting in only bread and seeds. When the lady returned the grosbeak seemed to be alarmed and suffering, and, examining him, she found a wound on his back, some skin and a little flesh being gone. Thinking that a mouse, or rat, or cat near the cage might be the author of the trouble, she dressed the injury with carbolic salve, and hung the cage higher. All went well until she was again absent for two days, and there was the same neglect of diet. On her return she found the grosbeak in a very low condition, and this time with a large hole in the fleshy part of the breast. The servant said that "twice the red-birds had been fighting the grosbeak." The fact was evident, craving stronger food, they had helped themselves from the living body of their poor little foster-father. The care and skill lavished on him, and a cage for himself, were not sufficient to save him, and he died the next day from the effects of his injury.

J. McNair Wright.

Space Relation of Numbers.

With reference to the graphic presentation of numbers in the imagination, narrated by Mr. Martin in a recent issue of *Science*, I may add the following personal record. I daresay it will be found, as in most such cases, that what Mr. Martin imagined as peculiar to himself, exists in some form or other in nearly all minds, though I do not recollect having seen any reference to it, a fact due doubtless to the limited character of my reading on the subject.

From an early age I remember noting the fact, at least as early as my sixteenth year and I think a year or two before, the period being one in which I passed from arithmetic to algebra and geometry, that it became apparent to me that in the first hundred numbers the first ten appeared to lie on a horizontal line, the next ten arose at right angles and that the remaining numbers, from twenty up to a hundred, lay with more or less distinctness, not so much as visualized numbers as concepts of numbers independent of symbol, in an inclined line at an angle of about thirty or forty degrees with the horizon. Beyond one hundred I have no imagination on the subject. I may add that I was taught in the ordinary mental and high school arithmetic before Grube's system had made

its appearance in American teaching. Precisely why these numbers should lie as they do, I was never able to see, although for many years I have been conscious of this arrangement and have wondered what its origin might be.

The letters of the alphabet arrange themselves for me in a visual way which is easily explainable. This is in three rows of eight each with Y, Z and Ampersand together below. The reason for this, I think, is that I learned to read without the preliminary of learning my letters, and after having been reading for several years, in my eighth year, my teacher made the agonizing discovery that while I was reading pretty much anything I pleased I did not know the order of my letters. I was, accordingly, set to work mastering an order which I will admit I have found most useful for every purpose except reading and writing. I learned the alphabet in this summary fashion out of a primer which had the alphabet disposed on its second page at the top of the page in the order which I have mentioned, and in all the manifold use of the alphabet for purposes of classification with which we are all familiar, but which we are apt to forget as a comparatively modern invention, the alphabet always seems to me to be in the three lines I have mentioned.

TALCOTT WILLIAMS.

COLUMBIAN CONGRESSES ON SCIENCE AND PHILOSOPHY.

AT least eight congresses were held during the week of August 21-26, and six are announced for Aug. 28-Sept. 2. The International Electrical Congress awakened much general interest, Professor Helmholz being a prominent figure. An illustrated lecture was given on the evening of Aug. 25, by Mr. Nikola Tesla, on Mechanical and Electrical Oscillators. This took place within the Exposition grounds, where about 70 per cent of the total horse-power of steam engines is used for electrical purposes. The Chamber of Delegates made their report on the special work entrusted to them.

The Congress on Psychical Science, with suggestions of spiritualism and hypnotism, also awaked some popular interest.

The Congress of Chemistry has been carefully worked up by Dr. H. W. Wiley, and 77 papers were announced. These were arranged in sections, as Analytical, Agricultural, Technological, etc.

Among the foreign chemists present, were Prof. Otto N. Witt, of Berlin; Prof. George Thoms, of Riga; Prof. H. R. Proctor, of Leeds; Prof. E. Engler, of Carlsruhe; and Prof. George Lange, of Zurich. X.

PALENQUE HIEROGLYPHICS.

IT is gratifying to learn that Dr. Valentini, after a long absence from the field of paleographic investigation, is about to return to it. There is one statement, however, in his communication to *Science*, Aug. 18, which needs correction. He says "Mr. Förstemann's theory of reading double columns is untenable." Now if he will refer to my "Study of the Manuscript Troano," printed in 1882, pp. 199-203, he will find this theory there set forth, as I think, for the first time, and, also, evidence of its correctness, which has apparently satisfied most students who are devoting attention to the Central American inscriptions and codices.

His statement that no month symbol appears on the tablets is made in face of evidence to the contrary, which seems to be conclusive.

I may add here that Dr. Brinton's acceptance (*Science*, Aug. 11) of the rendering given by me of the month name *Kayab*, necessarily forbids its derivation from *Kay* "to sing or warble." A compound of *ak* and *yab* cannot be a derivative of *Kay*. The *ak* may be obtained from the symbol on the rebus method of Aubin, which Dr. Brinton has rechristened by the name "Ikonomatic," but it is difficult to explain the symbol representing the last syllable *yab* by this method. If the name was formed as I suggested, and as admitted, (*Ak-yab*) the signification, with the month determinative added, is "the month when turtles abound."

CYRUS THOMAS.

Frederick, Md., Aug. 31.

COLOR VISION.

I AM very much surprised to see that Professor Ebbinghaus, in the last number of the *Zeitschrift fur Psychologie*, announces as new a discovery which has a critical bearing upon Hering's theory of color-vision,—the fact, namely, that two greys composed the one of blue and yellow and the other of red and green and made equally bright at one illumination do not continue to be equally bright at a different illumination. If two complementary colors were purely antagonistic, that is, if the color processes simply destroyed each other, as processes of assimilation and dissimilation must do, and if the resulting white was solely due to the residual white which accompanies every color and gives it its brightness, then the relative brightness of two greys composed out of different parts of the spectrum could not change with change of illumination. The fact that they do change is therefore completely subversive of the theory of Hering, or of any other theory in which the complementary color-processes are of a nature to annihilate each other. This consequence of the fact, as well as the fact itself, I stated at the Congress of Psychologists at London in August, 1892, and it was printed in the abstract of my paper which was distributed at the time and also in the Proceedings of the Congress.

Professor Ebbinghaus's discovery is apparently independent of mine, for he supposes that the phenomenon cannot be exhibited upon the color-wheel. This is not the case; with fittingly chosen papers (that is, with a red and green which need no addition of blue or yellow to make a pure grey, and with a corresponding blue and yellow) it is perfectly evident upon the color-wheel. The same paper circles which I used to demonstrate it in Professor König's laboratory, in Berlin, are, at the request of Professor Jastrow now on exhibition at the World's Fair at Chicago. While Professor Ebbinghaus's discovery of the fact is therefore doubtless independent of mine, I allow myself to point out that mine is prior to his in point of time.

CHRISTINE LADD FRANKLIN.

MYOLOGY OF THE CAT; OR THE M. FLEXOR ACCESSORIUS OF THE HUMAN AND FELINE FOOT.

THE supposed new muscle in the cat's foot (*Science*, Aug. 18, 1893, p. 97,) is, so far as Mr. Thompson's description allows of identification, probably no other than the

Accessoire du grand flechisseur (Bich.) of the Cat,
Accessoire du perodactylus (Str.-Dur.) of the Cat,
Caput plantare flexoris digitorum (Caro quadrata Sylvii) of Man,

or the M. flexor accessorius of human and feline anatomy

The flexor accessorius muscle in man originates by means of a muscular (internal and larger) head from the inner border of the calcaneum, which may be entirely absent, and by a tendinous slip which comes from the outer face of the Os calcis, just in front of the external tubercle, and from the long plantar ligament. As it has two quite constant sources of origin, so it has two insertions, one of which, however, is not constant. The usual insertion is that into the external border and upper surface of the M. flexor longus digitorum pedis, just where it divides into the four branches for the toes. (Most of the fibres of this

tendon pass to the third and fourth toes, some of the fibres go to the second toe, while few, if any, are sent to the fifth.)

But occasionally this muscle inserts entirely into the tendon of the M. flexor longus hallucis. The significance of this condition will be apparent when we examine the arrangement of the parts in the cat. But first let us take a glance at anthropoid anatomy. Among the apes the flexor accessorius is wanting. The flexor longus hallucis, instead of the flexor longus digitorum pedis, supplies the perforating tendons for the third and fourth toes, and in Hylobates, for even the second phalanx as well. In this way it helps out the latter muscle, which supplies, in these cases, only the second and the fifth phalanges, or only the fifth phalanx, while the hallux receives usually only a slender tendon, which, according to Bischoff, is entirely absent in the orang. This muscle (fl. accessorius) seems to be a portion of the primitive M. flexor fibularis, which has given rise to the two muscles, flexor long. hallucis and flexor long. digit. pedis. The accessory portion is not split off in the apes,—it is, in the case of man as well as in the cat, and here its point of origin has grown distad until all connection with the leg has been lost, except in those infrequent cases where it still passes up over the median face of the calcaneum into the region of the leg. In both man and the cat it strengthens the action of the two combined flexors of the digits, and by its lateral pull gives a different direction to their action. Innervation through N. plantaris lateralis (external plantar).

In Felis the accessorius is both less strongly developed and more transverse to the foot axis, in its course, than in man, and it is frequently entirely fibrous without any muscular tissue, *i. e.*, reduced to a mere ligament. When well developed it forms a small flattened plate which arises from the inferior portion of the external faces of the calcaneum and cuboid, from whence it passes inwards and downwards, posterior to the fused tendons of the Mm. flexor longus digitorum pedis and flexor longus hallucis to near where they fuse, at which place it inserts into the internal border of the tendon of the flexor long. hallucis. Usually the insertion is not confined to the internal border of this tenden but involves a greater portion of the broad tendinous plate formed by the fusion of the tendons of the two digital flexors above named. The fusion of their tendons practically makes a single muscle out of these two toe flexors. This is equally true of man. This fact helps to explain the varying insertion in man from a mechanical standpoint.

Briefly summarized.—The accessorius in man usually presents a muscular body, which, however, may be absent, while in the cat it is often absent and normally of much feebler development than in man. In the human subject the insertion is usually into the external border of the flexor longus digitorum pedis, though it may be entirely into that of the flexor longus hallucis, while in the cat the usual and best developed insertion is into the tendon of the latter muscle.

In conclusion, the muscle is an old friend, both in cat and man. HOWARD AYRES.

The Lake Laboratory, Milwaukee, Aug. 24, 1893.

DAMAGE TO COTTON BY LIGHTNING.

ON July 26, 1893, during a thunder storm there was one heavy report noticed in the direction of some cotton plats. The bolt seemed to have "struck" near the plats. The next day a spot in the midst of the plats was found where the most succulent parts of the plants were wilting. Examination showed no visible injury as the cause. There had previously been no sign of blight or disease, whatever, which could have caused the cotton to droop.

The rows run north and south, and five were affected; three for nearly a rod, the one on the east half that distance, and the fifth on the west very little, only two or three of the tallest plants being affected.

By common consent of those who saw the cotton it was agreed to be the work of the thunderbolt, and was so noted. No place where violence was done could be found in the soil.

Frequent observation during the first month has failed to see any increase in the blasted circle. In the whole space twenty-five or thirty plants have died, while others have low branches thriving and bearing fruit and flowers. If a fungus has done it some plants have *resisted* in part and succumbed in part, or the fungus has but partially done its work.

My notion of a discharge from an electrified cloud is that the interchange between it and the earth charged with the opposite pole is carried on by every leaf and point not repellant to the fluid; that if any plant from a tender annual up get more of the electric fluid than it can safely carry it will be injured according to the strength of the overcharge, even to total destruction, involving appearance of great physical violence, if the charge is heavy; and that the discharges take the line of least resistance, according to the common explanation of the zigzag course of lightning.

If this notion of lightning discharges is correct, is not the supposition that this particular occurrence is due to lightning based on tenable ground? Might not a bolt of lightning descend obliquely from one side or other, and when near the earth be deflected upward, but yet come near enough to the ground to destroy the life in the tallest of those plants while not destroying the low laterals of the shorter plants? Or may not this discharge be considered as having entered the earth through those plants with the observed effect to destroy so many of the first conductors—the tallest ones—and nearly all of the others nearest at hand; while of those furthest out only the highest points were harmed? FRANK E. EMERY.

Raleigh, N. C., Aug. 26.

ON SOME NESTING HABITS OF THE AMERICAN GOLDFINCH.

IT is probably a truth that every ornithologist has some bird which is his particular care to study; and being myself no exception to the rule, I thought perhaps a few notes on the nesting habits of the American Goldfinch, observed while collecting a large series of their nests and eggs, might be acceptable to the readers of *Science*.

Although found in southern Michigan throughout the winter in scattered flocks, it delays nesting until the latter part of July or the first of August. On studying the nests of the Goldfinch all will be found to be at least slightly different, yet there seem to be two distinct patterns in their architecture. The first and most common form is massively built and forms a thick cushioned receptacle for the eggs. An example of this class, which I have before me, has walls about an inch thick, while the distance to the bottom of the crotch in which it is situated is about three inches. The whole mass is composed of very fine fibres and thistle-down; and as this pattern of nest is usually situated where the twigs are thickest, it may easily be seen what a useful purpose it serves in deadening the force of a sudden blow or jar, which might otherwise result disastrously to the eggs. A two-storied nest of this kind I found in a blackberry bush on August 3. The lower

nest containing a Cow-bunting's egg, over which was built another nest containing six eggs of the Goldfinch.

In the nest of the second form the walls are much thinner, and the general form and structure much resemble a Vireo's nest. These beautiful frail structures, however, are much better adapted to their position on the ends of branches than the thick nests would be if placed in that position.

The eggs are from three to six in mumber, most commonly five, blue, unspotted, save in the instance of two sets evidently belonging to the same pair of birds, which I found, one set in 1890, the other in '91, in the same tree. The eggs were finely spotted with reddish brown forming a wreath around the larger end. I have never heretofore seen an instance of spotted eggs of the Goldfinch noted in ornithological publications, and I believe their occurrence is somewhat uncommon.

PAUL VAN RIPER.

PHYSICAL CHEMISTRY AT THE COLUMBIAN CONGRESS.

THE recent doctrines of chemical energy are pushing towards the front. The opening paper on physical chemistry was presented to the Congress by the writer of this report, who called attention to the valuable results arising from "the cross-fertilization of the sciences." The physical properties of substances have long been studied, under the name of chemical physics; such data are indispensable in chemical analysis, technology, etc. But, with transposition of the terms, we find more attention given to the properties of energy itself, and to the conditions of equilibrium, and of rapid or slow change. These generalizations promise to be most fruitful of results, and deserving of general recognition in our universities.

The second paper, "on chemical energy," was contributed by Professor Ostwald, of Leipsic, who is indefatigable, both in research and in expounding the progress of science. The two factors, capacity and intensity, are discussed and illustrated in this paper, with great perspicuity. Capacity is proportional to the mass; for two tons of coal, by combustion, will yield twice as much heat as one ton. To estimate the intensity, on the other hand, we may remember that heat conduction always implies some difference in heat intensity; so, a chemical transformation implies greater intensity of chemical energy in the reacting bodies than in the reaction products, under comparable conditions. A "chemometer" anologous to thermometer, though not yet complete, is not wholly unknown. Emphasis is given to the theorem, "two potentials which individually are equal to a third are equal to each other," with important deductions therefrom; and catalytic bodies are discussed in relation to the acceleration of chemical change.

A third paper, by Prof. J. E. Trevor, of Ithaca, states the fundamental equations of equilibrium, for three leading cases, and presents some extended mathematical deductions.

Three other communications, assigned to this section, are of more varied character. Prof. E. W. Morley stated by request some of his results in determining the atomic weight of oxygen, with remarkably close agreement, at about 15.88; but the work is still in progress.

Professor Lunge, of Zurich (whose genial presence added much to the interest of the Congress) described apparatus for promoting the interaction of liquids and gases. Perforated earthenware plates, of special form, are so placed as to promote contact of the reacting substances,—as in sulphuric acid manufacture.

Prof. T. H. Norton communicated a paper from Professor Orndorff, illustrating by models the stereochemistry of paraldehyde and metaldehyde $(C_2H_4)_3$. The three methyl groups are assumed in one case to be all on one side of the plane of the carbon-oxygen ring; and in the other case to be distributed on both sides.

ROBERT B. WARDER.

HOWARD UNIVERSITY, WASHINGTON D. C.

GREAT HORNED OWLS IN CONFINEMENT.

WHILE collecting in some dense pine woods early in April, 1886, I saw a great horned owl about every day which flew from a nest in a pine tree. This tree was the tallest of its kind in the vicinity, and the nest was at least seventy-five feet from the ground. Thinking I might secure its eggs or young, I climbed the tree and found, much to my disgust, that the bird used the nest only as a roosting place.

By patient watching and hunting I discovered its nest April 19, in a large chestnut tree. It was composed of coarse sticks and was lined with feathers and down from the parent bird, and had the appearance of having been a deserted hawk's nest.

Here I found two young birds which were covered with down and were about half grown. Their tail and wing feathers were just starting out. They tried to defend themselves like an adult bird by keeping up a continual hissing and blowing sound, and at the same time snapping their bills and opening and closing their eyes. I noticed that they occasionally made a low, murmuring sound, and also a louder and harsher note, which they make now when hungry.

In the nest with them were two half-eaten fish, *Catostomus communis*, and the hinder portion of two brown rats. When in confinement, a week or two later, they ate voraciously, and one day I offered one a dead mourning dove. It seized it head first, and in a very few minutes succeeded in swallowing it entire, except the tips of its tail feathers, which protruded from its mouth. I expected then it would fall a victim to its gluttony, but within a very short time the tail feathers had disappeared, and it remained very quiet for two or three hours, after that it showed no discomfort whatever from its meal.

April 27 they could walk quite well, and about June 15 the feathers started out on the head of the smaller bird, which I believe to be a male, although it was by far the larger when taken from the nest.

The feathers on the larger, or female bird, did not appear until July 4, and at this date the wing and the tail feathers on both were full grown. After this time they consumed but a small portion of the food they formerly did, although they occasionally ate voraciously. They seem to prefer rats, mice, birds and are quite partial to beef.

About the middle of October the larger, and what I believe to be the female bird, began to hoot, but not very loud. This is performed by the bird standing at its full height, with its ear-tufts (which were fully developed October 1) erect, but slightly slanting backward, and swelling out its throat it gives utterance to the notes, "waugh ho ho ho ho."

They recognize all strangers, and appear afraid of dogs, horses and cows, but always show fight and act on the defensive. Their way of showing fight is to lower their head and tail, and spread their wings to nearly their full extent, but arching them so as to protect their body, and at the same time utter a peculiar blowing or hissing sound, accompanied with a snapping of their bills.

They have been confined in a large cage for over seven years, and during this time have showed no inclination to breed, and when not disturbed have made no attempts to escape, but sit quietly on their perches through the day. Just after dark they move about considerably.

Their "hootings" seem to be confined to no especial season of the year, but can be heard almost any night, and are quite noisy moonlight nights.

As they grow older they consume less food, and are not fed oftener than every other day. They are strong and vigorous, and, as a proof of their muscular powers, I once saw the female lift a dead turkey, which weighed no less than eight pounds, bodily, from the ground.

Their sense of hearing is especially good; the least noise always attracts their attention. As for their eyesight, in broad daylight no birds could be better, as I have frequently noticed them looking at birds, which were flying over, at very great heights, on very clear and bright days.

They have never made any attempts to breed whatever, nor has either one shown any affection for the other, although they seem to be on the best of terms, except when eating they occasionally have a scrimmage over a piece of meat. WILLARD E. TREAT.

East Hartford, Conn.

BOOK-REVIEWS.

An Introduction to the Study of the Dependent, Defective and Delinquent Classes. By CHARLES RICHMOND HENDERSON. Boston: D. C. Health & Co. 12°, 272 p. $1.50.

THE author of this book has been for more than twenty years a student of the classes of which it treats, and has been connected with many agencies for their improvement and reformation. He has not only been a close observer of those classes and of the methods that society has adopted for dealing with them, but is also widely read in the literature of the subject; and his book shows that he has read with discriminating judgment and to good purpose. Mr. Henderson is assistant professor of social science in the University of Chicago, and evidently had his pupils in mind in preparing this book; for it is not designed for those professionally engaged with the dependent and criminal classes, but rather for the educated citizen, who only wants a general knowledge of the subject. The book is divided into three parts, corresponding to the three classes of which it treats; and these parts are again divided and sub-divided into chapters and sections; the work of division and systematization being carried, as it seems to us, to excess, since it gives the treatise too formal a character without adding to its scientific value. The author expresses himself plainly and with judicial temper, and has no hobbies, scientific or practical, to cloud his judgment.

The part of the book relating to the defective classes, such as the insane, the blind and others, is quite short, the author evidently feeling that the treatment of those classes is rather out of the range of social science. The chapters concerning pauperism, its causes and remedies are good; and though they contain nothing new or striking, they present the best views now prevalent and also the methods now employed by the leading nations in their treatment of the poor. But by much the larger portion of the volume is devoted to the criminal classes, with special chapters on the criminal type and on the causes of crime and the best methods of dealing with it. Mr. Henderson, though evidently familiar with the Italian writers and others who regard crime as similar to disease and as largely due to biological causes, does not share their views; but maintains that the source of crime is in the moral nature, and consequently that remedies and preventives must be such as will have a moral effect. At the same time he by no means overlooks the fact that criminals are of different kinds, and that in the case of some of them poverty and other unfavorable circumstances have been contributive causes of their crime. We commend the book as a convenient introduction to the subject with which it deals.

Alternating Currents of Electricity: By Gisbert Kapp, C. E., M. I. C. E., M. I. E. E., With an introduction by William Stanley, Jr. New York: W. J. Johnston Co.

ALTERNATING current work has been developed so recently that there are a large number of electrical engineers in the profession who finished their technical education before the subject had attracted much attention. Of these a goodly number have since worked up the subject, among them being some of the best-known specialists in that branch.

Others, however, have not been so fortunate. Thrown into out of the way places in the exercise of their profession, they have not had the opportunity or time to follow up the subject.

To such this little book may be recommended as an introduction to the more mathematical treatises of Fleming, Blakesley, and Crehore and Bedell.

It deals with the subject in the most elementary way, so simply that it is practically impossible for any one with the most superficial knowledge of electricity not to arise from its perusal without a knowledge of the main characteristics of an alternating current, how it differs from a continuous current, the principles of the working of alternating current apparatus, and the ability to read the more mathematical treatises comprehendingly and understandingly.

The introduction is somewhat of a disappointment, as it contains, with the exception of a pertinent warning against the fallacy of supposing that the field produced by a two-phased current is more irregular than that of a three-phased current, practically nothing but a review of the book. One feels that more might have been looked for from one who has been so long in alternating current work and has done so much for its development.

There are few things that can be criticised in the book itself. The mathematical proof of the expression for the mean current, given on page 45 might be altered for the better, as it is not usual to change the variable in an integral without changing the limits between which the integral is taken, nor to integrate an angular expression between time limits.

The explanation of magnetic leakage on page 95 may also be objected to. Lines of magnetic induction are caused by a magneto-motive force, and magneto-motive force is a vector quantity. Consequently, when two magneto-motive forces are superimposed, there is not a formation of lines of magnetic induction corresponding to each of the magneto-motive forces, but one set of lines corresponding to the resultant M. M. F.

In conclusion it may be said that, to those who are in want of a very elementary book on alterning currents, this treatise will supply what is desired.

R. A. F.

The last number of Vol. V. of the *American Journal of Psychology*, which has just been issued, contains practical suggestions on the equipment of a psychological laboratory by Dr. E. C. Sanford. A study of Pseudo-chromesthesia, mostly among the students of Wellesley College, by Professor Mary W. Calkins, illustrated by many new diagrams and tables. A brief system of Ejective Philosophy, in seven pages, by T. P. Bailey. An attempt to explain the Hegelian Philosophy psychologically, by A. Fraser. The longest and most popular article is an account of the Neo-Christian Movement in France, by J. H. Leuba, a Frenchman by birth and education and Fellow at Clark University. The artistic sensualists, Huysmans, Beaudelaire, the school of decadents, illustrated by Kahn Réné Ghil and Mallarmé; "the literary critics and chronicles," "the tormented," like G. Duruy, Jounet, Lasserre, Bouchor, Bourget, etc., are characterized with just discrimination and knowledge. The Neo-Christian movement proper, represented by Lavisse, De Vogué and Desjardins, concludes a sketch which constitutes by far the best presentation of these remarkable literary movements that have yet appeared in English. The usual reviews follow.

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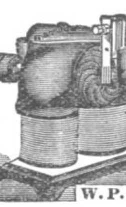

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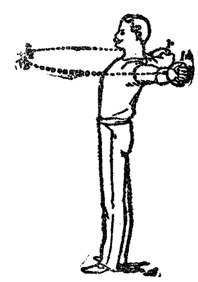

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